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# The welfare effects of government's preferences over spending and its financing

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## Abstract

In this paper we examine the welfare effects of government's preferences over consumption and investment spending under different methods of financing in a two-period OLG model. The government has a utility function defined over the decomposition of her spending over two periods and raises funds by issuing bonds and by printing money. She allocates her funds into consumption expenditure that benefits the current population and investment expenditure which benefits the future population. The model is calibrated using data on the U.S. economy for the period 1981-2004. The findings reveal that the government's choice of financing as well as composition of spending into consumption-investment have differing impacts on the welfare of the young and old generations.

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*Keywords:* Seigniorage; Bond financing; Composition of government spending; Overlapping generations

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# 1 Introduction

The composition of government spending is crucial in assessing the intergenerational distribution of the benefits from it. While government consumption yields benefit to the current generation, government investment profits the future generations. In addition, the form of the financing of these expenditures raises additional questions on how the intergenerational burden of government budget financing is distributed. For example, while inflationary finance is a burden on the current generation, borrowing through issuing government bonds may be considered as a burden on the future generation. In addition, it is possible to consider life-time tax rates of different generations as a way of distributing the burden of government budget financing across generations. In these respects, an equitable distribution might be thought of as the one where these burdens and benefits are balanced across generations. However, in practice this may be difficult to achieve as political factors influence the government's objectives.

Understanding the welfare effects of the composition of government spending and the composition of different financing options is the purpose of this paper. Specifically, we are interested in the distribution of the burden via inflationary versus bond finance as this allows us to consider a monetary policy option versus a fiscal policy option besides having different implications in terms of the burden on different generations.<sup>1</sup>

A strand of literature investigates the composition of the financing side only, neglecting the composition of government spending. In this regard, Helpman and Sadka (1979) use an overlapping generations model to compare the implications of bond, money and tax financing. Later, Sargent and Wallace (1981) and Jovanovic (1982) analyze the tradeoff between seigniorage and bond financing. More recently, Fung, et al. (2000) study bond financing versus seigniorage while Hung (2005) investigates income taxation versus seigniorage.<sup>2</sup>

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<sup>1</sup>The concept of generational burden within the context of macroeconomic effects of fiscal policy is introduced by the literature involving generational accounting of Kotlikoff (1986, 1992, 1993), Auerbach and Kotlikoff (1987), and Auerbach, et al. (1994). Buiter (1997) suggests that the generational burden assessment as in generational accounting is incomplete without an analysis of intergenerational distribution of welfare.

<sup>2</sup>A closely related question is investigated through a vast literature on Ricardian equivalence. See, for example, McCandless and Wallace (1995) for the result on how alternative patterns of lump-sum taxes and corresponding borrowing schemes results in an equilibrium with the same consumption, government expenditures and gross interest rates. This

Another strand of literature studies the composition of government spending, without paying attention to alternative ways in which it is financed. Kormendi (1983) considers the composition of government spending, i.e. government investment and government consumption, and its effects on households. Later, Finn (1998) focuses on spending composition, specifically on spending on public employment versus goods, and their effects on private sector. In a dynamic general equilibrium context, Ardagna (2001) investigates the effect of changes in the composition of government's spending items and government's revenue items on economic activity and public finance. Recently, Ganelli (2005) extends these ideas on changes in the composition of government spending in an open economy environment.

Our paper integrates the two strands of literature by investigating the impact of the composition of government spending and finance on welfare.<sup>3</sup> To model the intertemporal heterogeneity in the consumer preferences over the composition of government spending or indirectly over the composition of financing, this paper introduces an OLG model. In terms of financing, only inflation tax or seigniorage and bond financing are considered.<sup>4</sup>

Two important features of our model are the way the utility (objective) functions of the households and the government are introduced. In the model, individuals receive utility from their own private consumption as well as government's consumption and investment. Private consumption and government's spending (both consumption and investment) are imperfect substitutes.<sup>5</sup> In addition, we adopt a two-period utility function for the government that discounts the future. Accordingly, the government may put less

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however analyzes alternative fiscal policy options ignoring monetary issues. An early work by Aschauer (1985) investigates whether taxation or debt financing have significant effects on consumption and finds that Ricardian equivalence is not rejected.

<sup>3</sup>The studies by David and Scadding (1974) and von Furstenberg (1979) are the closest in spirit to our approach. They couple government consumption with taxation and government investment with debt financing to investigate implications on output. However, these models lack micro foundations, hence fall short of providing a welfare analysis. Integrating the two strands of literature, Aschauer (1998) analyzes the optimal financing of government spending. His findings indicate that productive government spending should be financed by money creation while unproductive spending should be financed by income taxation. But both of these financing options place a burden on the current generation.

<sup>4</sup>Although conventional taxation is not considered, our results readily extend to the case in which each generation when young is taxed in a lump-sum fashion.

<sup>5</sup>For some other formulations of government spending in the household utility functions, see Ganelli (2003), Finn (1998), and Aschauer and Greenwood (1985).

weight to her spending items which yield benefit to the future generations, while a larger weight may be placed for the items that are beneficial to the current generation in line with the idea of “political business cycles”.<sup>6</sup> Moreover, this utility function reflects the government’s dislike of debt through the introduction of the default probability.

Our theoretical model does not deliver closed form solutions. Hence, we calibrate the model using the U.S. data between 1981-2004 and find a number of different equilibria corresponding to the controlled sets of parameters. Next, we run regressions for each endogenous variable in equilibrium on the set of parameter values associated with these equilibria to assess comparative static results in equilibrium. In addition, we also conduct welfare analysis via similar regressions and uncover that money creation as a financing instrument alternative to debt creation increases government’s utility and reduces the old household’s utility. Additionally, the form of budgetary financing is immaterial for the young household unlike in the literature.<sup>7</sup>

The main contribution of our paper is the predisposition of the private households towards the preferences of the government over public consumption and public investment. The lifetime utility of the current generation is higher with a government that favors investment over consumption. On the other hand, the current old does not unambiguously prefer a myopic government that always favors consumption over a forward looking one that places emphasis on investment.

The rest of the paper is organized as follows. Section 2 presents the model and Section 3 describes the monetary competitive equilibrium where the results of the calibration exercise are also discussed. Section 4 concludes.

## 2 Model

The economy is populated with overlapping generations of households who live for two periods. In each period  $t$ , there exists a young generation with  $L_t$  members and an old generation with  $L_{t-1}$  members. The young generation, and hence the overall population, is assumed to grow at a constant rate  $n$ ,

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<sup>6</sup>Persson and Tabellini (1990), page 79, states “... the prediction of the [political business cycle] theory is that policymakers overstimulate the economy before elections and contract it after elections to reduce inflation ...”.

<sup>7</sup>See Chapter 10 of McCandless and Wallace (1991) for a thorough discussion of the welfare effects of money transfers and seignorage.

i.e.,

$$L_t = (1 + n)L_{t-1}. \quad (1)$$

In each period, only one composite, perishable good exists. Each household (agent, interchangeably) receives an endowment in terms of the composite good when young, and uses part of it for consumption and saves the rest for future consumption. Savings can be in terms of holdings of government bonds that mature in one period or in terms of money printed by the government. The agent earns a real interest rate of  $r_t$  on his bond holdings while money, which is fully backed unlike the bonds, pays the return stemming from the change in its prices (defined in units of the consumption good) over an investment (holding) period.

Government chooses the level of government consumption and government investment for the two periods. These expenditures are financed by issuing bonds and/or printing money. We assume that the government does not earn tax revenues in terms of income taxes or lump-sum taxes, and in addition, there are no transfers.

In each period, the young agent decides on his consumption and the composition of his savings, while the government decides on the composition of her expenditure. Once these decisions are made, the government sells bonds and money to the young agents to finance its deficit, and the old agents collect their receivables on bonds while using their money holdings to purchase goods from the young agents.

## 2.1 Households

Households' preferences are characterized by an intertemporal utility function given by

$$U_t = (G_t^C + G_{t-1}^I) \ln(c_{1,t}) + \beta^H (G_{t+1}^{C,e} + G_t^I) \ln(c_{2,t+1}^e) \quad (2)$$

where  $\beta^H \in (0, 1]$  is the subjective discount factor,  $c_{1,t}$  and  $c_{2,t+1}^e$  denote the current and expected consumption levels of a representative household of generation  $t$  when he is young and old, respectively. Each household is assumed to value the current and the expected future government consumption,  $G_t^C$ , and  $G_{t+1}^{C,e}$  while utility from government investment,  $G^I$ , for the household is realized with one period lag, as it takes time for investment

projects to be completed. In this formulation, the marginal utility of private consumption increases with government expenditures.<sup>8</sup>

The agent receives an endowment of  $w_{1,t}$  in terms of the perishable composite good when young. So, the total GDP of the economy in period  $t$  becomes  $L_t w_{1,t}$ . We assume that the endowment of the young, hence the total GDP, grows at a constant rate  $g$ , i.e.,

$$w_{1,t} = (1 + g) w_{1,t-1}. \quad (3)$$

The budget constraint of the young household can be written as

$$c_{1,t} + s_t = w_{1,t} \quad (4)$$

where  $s_t$  is his real savings that are invested in the two assets: money and bond. We assume that the time  $t$  price of one unit of money (in terms of consumption good) is  $p_t$  and that bonds are issued in terms of the consumption good. Thus we have

$$s_t = b_t + p_t m_t \quad (5)$$

with  $b_t$  and  $p_t m_t$  denoting the real bond and money holdings of the agent. Let

$$\mu_t = \frac{p_t m_t}{s_t} \quad (6)$$

denote the share of the young household's savings that are invested in money. It then follows that  $(1 - \mu_t)$  determines the share of savings invested in bond as in

$$b_t = (1 - \mu_t) s_t. \quad (7)$$

When the agent is old, he consumes his accumulated savings. For we assume that money is fully backed by the government,  $m_t$  units of fiat money yields  $p_{t+1}^e m_t$  units of consumption good at the next period's expected price  $p_{t+1}^e$ . But, the bond as an alternative asset of investment bears the risk

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<sup>8</sup>If private consumption and public expenditure were perfect substitutes, then optimal current consumption varies negatively with current spending and positively with future spending. Equation (2) suggests otherwise, as consumption and government spending are imperfect substitutes. For example, an individual gets a higher utility from his lunch when he has it at a well-kept public park. Likewise, a well-connected network of roads reduces congestion thereby increasing private utility.

of its issuer's default of repayment. For simplicity, we set the probability (perceived risk) of this default to the share of total debt issued in the total GDP of the economy, i.e.  $B_t/(L_t w_{1,t})$ , where  $B_t$  is the aggregate bond stock in period  $t$ . Each period government inherits past period's debt service which, we assume, determines the default probability in the current period.

Noting that bonds yield the gross real rate of return  $(1 + r_t)$  with the no-default probability  $(1 - B_t/(L_t w_{1,t}))$  and zero gross return with the default probability, we can write the expected consumption of an old household in period  $t + 1$  as follows:

$$c_{2,t+1}^e = p_{t+1}^e m_t + \left(1 - \frac{B_t}{L_t w_{1,t}}\right) (1 + r_t) b_t \quad (8)$$

Using (5) and (6), the reduced problem of the representative household can be written as

$$\max_{c_{1,t}, \mu_t} (G_t^C + G_{t-1}^I) \ln(c_{1,t}) + \beta^H (G_{t+1}^{C,e} + G_t^I) \ln(c_{2,t+1}^e) \quad (9)$$

subject to

$$c_{1,t} \in (0, w_{1,t}] \quad (10)$$

$$\mu_t \in [0, 1] \quad (11)$$

$$c_{2,t+1}^e = \left(\mu_t \frac{p_{t+1}^e}{p_t} + \left(1 - \frac{B_t}{L_t w_{1,t}}\right) (1 - \mu_t) (1 + r_t)\right) (w_{1,t} - c_{1,t}). \quad (12)$$

## 2.2 Government

The government is elected for two periods with a possibility of being reelected in the coming term. She chooses her consumption and investment levels by maximizing her utility function subject to her budget constraint. The utility of the government,  $V_t$ , is also assumed to be additively separable over the periods and has the following form:

$$\begin{aligned} V_t = & \left(1 - \frac{B_{t-1}}{L_{t-1} w_{1,t-1}}\right) \theta_1 \ln(G_t^C) \\ & + \beta^G \left(1 - \frac{B_t}{L_t w_{1,t}}\right) [\theta_2 \ln(G_{t+1}^C) + \eta \ln(G_t^I)] \\ & + (\beta^G)^2 \left(1 - \frac{B_{t+1}}{L_{t+1} w_{1,t+1}}\right) \delta \ln(G_{t+1}^I) \end{aligned} \quad (13)$$



where  $\beta^G \in (0, 1]$  is the discount factor of the government,  $\theta_1, \theta_2, \eta, \delta \in (0, 1]$  are the respective weights for the utilities from consumption and investment,  $G_t^C$  and  $G_t^I$  denote government consumption and investment in period  $t$ . As values of investment expenditures are realized with one period lag, government investment made in time  $t$  is assumed to affect period  $t + 1$  utility. In addition, the government may also care about generations to come and/or considers the possibility of being reelected. Thus,  $G_{t+1}^I$  enters in the utility function of the government with the parameter  $\delta$  capturing, say the probability of being reelected. All terms in the utility function of the government are multiplied with each period's respective probability of no default.<sup>9</sup>

Generally, macroeconomic models have a benevolent government who maximizes the indirect utility of the households. A utility function that we attribute to the government in equation (13) is novel. This utility specification captures the government's preference across government investment and consumption, which benefits different generations. This can be justified on the premise that the government is an active player who gains her political power from her constituents who, in turn, are directly affected by the composition of government spending. Therefore, this utility function can be thought of as representing the balance between her political objectives and welfarist conduct.<sup>10</sup>

The budget constraints of the government are

$$G_t^C + G_t^I + r_{t-1}B_{t-1} = I_t \quad (14)$$

$$G_{t+1}^C + G_{t+1}^I + r_t B_t = I_{t+1} \quad (15)$$

where  $G_t^C + G_t^I$  is the current government expenditures,  $r_{t-1}B_{t-1}$  is the interest payments on maturing debt. The left-hand-side of equations (14) and (15) show the budget deficit that needs financing in each period, and  $I_t$  and  $I_{t+1}$  are exogenously determined at the beginning of the government's term. The budget deficit can be financed through printing money and issuing bonds; that is,

$$I_t = p_t \Delta M_t + \Delta B_t \quad (16)$$

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<sup>9</sup>That the government's expected utility is decreasing in its default probability can be motivated by situations in which the government may be bound by a performance criteria, like Maastricht criteria of maximum 60 percent debt-to-GDP ratio, or may receive a political bonus when the ratio is kept low.

<sup>10</sup>For example, when  $\beta^G$  approaches zero in equation (13), the government becomes extremely myopic and non-welfarist if the elections are held every period. When  $\beta^G = 1$ , the government is extremely far-sighted (forward-looking) and welfarist.

$$I_{t+1} = p_{t+1}^e \Delta M_{t+1} + \Delta B_{t+1} \quad (17)$$

where  $\Delta M_t = M_t - M_{t-1}$  denotes the amount of money printed by the government in period  $t$ .

We assume that  $M_t = (1 + \gamma)M_{t-1}$  where  $\gamma$  is the constant growth rate of money. Moreover, the real money holding as a fraction of the real GDP is constant across periods satisfying

$$p_t M_t = k w_{1,t} L_t \quad (18)$$

where the constant  $k \in (0, 1)$  is the inverse of the velocity endogenously determined in equilibrium. While the velocity of money is constant for the two-period life of government (or for a given set of parameters in the economy), unlike in a classical model, this velocity is not constant with respect to money growth rate (or over different equilibrium points associated with different set of parameters). Hence, this is a Keynesian model which allows money to be held for speculative purposes.

The government's reduced problem is to maximize equation (13) subject to equations (14) and (15) by choosing  $G_t^C$ ,  $G_t^I$ ,  $G_{t+1}^C$ , and  $G_{t+1}^I$ .

### 3 Monetary Competitive Equilibrium

We assume that both the government and households have perfect foresight; thus  $G_{t+1}^{C,e} = G_{t+1}^C$ ,  $p_{t+1}^e = p_{t+1}$ , and  $c_{2,t+1}^e = c_{2,t+1}$ . The set of sequences  $\{p_t, p_{t+1}, \mu_t, r_t, B_t, B_{t+1}, c_{1,t}, c_{2,t+1}, G_t^I, G_t^C, G_{t+1}^C, G_{t+1}^I\}$  is a monetary competitive equilibrium of our described economy, if  $p_t, p_{t+1} > 0$  for all  $t$ , and

- i) for the government,  $\langle G_t^C, G_t^I, G_{t+1}^C, G_{t+1}^I \rangle$  maximize equation (13) subject to equations (14) and (15),
- ii) for each household,  $\langle c_{1,t}, c_{2,t+1} \rangle$  maximize (9) subject to (10)-(12),
- iii) both the money market and the bond market clear; i.e.  $L_t m_t = M_t$  and  $L_t b_t = B_t$ .

**Proposition 1.** *Given the exogenous variables  $\{w_{1,t-1}, L_{t-1}, M_{t-1}, I_t, I_{t+1}\}$ , the initial values of the endogenous variables  $\{r_{t-1}, B_{t-1}\}$  and the parameters  $\{\gamma, g, n, \beta^H, \beta^G, \theta_1, \theta_2, \eta, \delta\}$ , a monetary competitive equilibrium satisfies (19)-(31) for all  $t$ :*

$$G_t^C = \frac{I_t - r_{t-1} B_{t-1}}{1 + \frac{\beta^G \eta}{\theta_1} \frac{1}{(1+n)(1+g)} \frac{L_t w_t - B_t}{L_{t-1} w_{t-1} - B_{t-1}}} \quad (19)$$

$$G_t^I = \frac{I_t - r_{t-1}B_{t-1}}{1 + \frac{\theta_1}{\beta^G \eta} (1+n)(1+g) \frac{L_{t-1}w_{t-1} - B_{t-1}}{L_t w_t - B_t}} \quad (20)$$

$$G_{t+1}^C = \frac{I_{t+1} - r_t B_t}{1 + \frac{\beta^G \eta}{\theta_2} \frac{1}{(1+n)(1+g)} \frac{L_{t+1}w_{t+1} - B_{t+1}}{L_t w_t - B_t}} \quad (21)$$

$$G_{t+1}^I = \frac{I_{t+1} - r_t B_t}{1 + \frac{\theta_2}{\beta^G \eta} (1+n)(1+g) \frac{L_t w_t - B_t}{L_{t+1}w_{t+1} - B_{t+1}}} \quad (22)$$

$$\frac{p_{t+1}}{p_t} = \left(1 - \frac{B_t}{L_t w_{1,t}}\right) (1 + r_t) \quad (23)$$

$$c_{1,t} = \frac{\Gamma_t}{\Gamma_t + \beta^H} w_{1,t} \quad (24)$$

$$c_{2,t+1} = \frac{\beta^H}{\Gamma_t + \beta^H} w_{1,t} \frac{p_{t+1}}{p_t} \quad (25)$$

$$\Gamma_t = \frac{G_t^C + G_{t-1}^I}{G_{t+1}^C + G_t^I} \quad (26)$$

$$p_t = \mu_t \frac{L_t w_{1,t}}{M_t} \frac{\beta^H}{\beta^H + \Gamma_t} \quad (27)$$

$$B_t = (1 - \mu_t) L_t w_{1,t} \frac{\beta^H}{\beta^H + \Gamma_t} \quad (28)$$

$$I_t + B_{t-1} = \left(1 - \frac{\mu_t}{1 + \gamma}\right) L_t w_{1,t} \frac{\beta^H}{\beta^H + \Gamma_t} \quad (29)$$

$$I_{t+1} + B_t = \gamma \mu_t L_t w_{1,t} \frac{\beta^H}{\beta^H + \Gamma_t} \frac{p_{t+1}}{p_t} + B_{t+1} \quad (30)$$

$$\frac{p_{t+1}}{p_t} = \frac{(1+g)(1+n)}{1+\gamma} \quad (31)$$

**Proof.** We can first substitute for  $G_t^I$  and  $G_{t+1}^I$  in the government's objective function (13) using the budget constraints (14) and (15). The first-order

necessary conditions (FONC) associated with the choice variables  $G_t^C$  and  $G_{t+1}^C$  are

$$\left(1 - \frac{B_{t-1}}{L_{t-1}w_{1,t-1}}\right) \frac{\theta_1}{G_t^C} = \left(1 - \frac{B_t}{L_t w_{1,t}}\right) \frac{\beta^G \eta}{I_t - r_{t-1}B_{t-1} - G_t^C} \quad (32)$$

and

$$\left(1 - \frac{B_t}{L_t w_{1,t}}\right) \frac{\theta_2}{G_{t+1}^C} = \left(1 - \frac{B_{t+1}}{L_{t+1} w_{1,t+1}}\right) \frac{\beta^G \delta}{I_{t+1} - r_t B_t - G_{t+1}^C}, \quad (33)$$

respectively. By the strict concavity of  $V_t$  in (13), we thus obtain (19)-(22) as the unique optimal solution to the government's problem.

Similarly, for the reduced problem of a household, the FONC associated with  $c_{1,t}$  is

$$\frac{G_t^C + G_{t-1}^I}{c_{1,t}} = \beta^H \frac{G_{t+1}^C + G_t^I}{c_{2,t+1}} \left( \mu_t \frac{p_{t+1}}{p_t} + \left(1 - \frac{B_t}{L_t w_{1,t}}\right) (1 - \mu_t)(1 + r_t) \right) \quad (34)$$

whereas the FONC associated with  $\mu_t$  is (23). Using (12), (23), (34), the assumption  $p_{t+1}^e = p_{t+1}$ , and the strict concavity of  $U_t$  in (9), we obtain the unique optimal consumption choices of the representative household as defined by (24)-(26).

Equation (27) is obtained from (4), (6), (24) using the money market clearing condition  $L_t m_t = M_t$ . Similarly, (4), (7), (24) and the bond market clearing condition  $L_t b_t = B_t$  yield (28).

Using (28), government's budget equations (16) and (17) are reduced to (29) and (30) in the equilibrium. Finally, from (18) and its one period lead, we get (31). *Q.E.D.*

An immediate remark about Proposition 1 is that money is neutral as the level of the money stock,  $M_t$ , enters into the (real commodity) price (of money) equation (27), only. But, money is not superneutral for it is apparent from (24), (25), (26) and (31) that the growth rate of money,  $\gamma$ , affects the time allocation of private consumption and/or the composition of government spending. However, the exact analytical relationship between money inflation and private and public expenditures is not available since no closed form solution for the equilibrium conditions (19)-(31) exists. Hence, we are unable to predict the direction of change in any of the model variables in response to changes in parameters. However, conditional upon a decrease

in the bond stock in response to an increase in money inflation (which is actually the case in our regression results), one can analytically predict the direction of change in some endogenous model variables.

### 3.1 Calibration and Comparative Statics

We calibrate the monetary equilibrium of our model for the U.S. economy over the period 1981-2004, which was divided into three subperiods; 1981-1990, 1991-2000, 2001-2004 representing  $t-1$ ,  $t$  and  $t+1$  in the model, respectively. We use period averages of relevant variables obtained from the web site of the Economic Research Department of the Federal Reserve Bank of St. Louis.

Based on the 10-year periods, population growth rate  $n$  for each period is set to 0.10 (which implies an average annual population growth rate of 1%), the period  $t$  level of real GDP 83.10 billions of U. S. dollars deflated by (2000=100) GDP deflator, the period  $t-1$  real money stock  $M_{t-1}$  (using M1 definition) to 8.86 billions of U.S. dollars in 2000 prices, the period  $t$  real budget deficit (inclusive of real interest payments)  $I_t$  to 26.23 billions of U.S. dollars in 2000 prices, the period  $t+1$  real budget deficit (inclusive of real interest payments)  $I_{t+1}$  to 31.60 billions of U.S. dollars in 2000 prices, the period  $t-1$  real interest rate  $r_{t-1}$  to 0.0547, the period  $t$  real bond stock  $B_t$  to 21.98 billions of U.S. dollars in 2000 prices. We set  $L_{t-1}$  to 122.73 million and  $w_{1,t-1}$  to 554 U. S. dollars deflated with (2000=100) GDP deflator.

Over the 10-year-long periods ( $t-1, t, t+1$ ), we vary the money growth rate between 0.50 and 1.15 by increments of 0.05, the real GDP growth rate between 0.20 and 0.55 by increments of 0.05, the parameters  $\beta^G$  and  $\beta^H$  between 0.9 and 1.0 by increments of 0.025, and the parameters  $\theta_1$ ,  $\theta_2$ ,  $\eta$  and  $\delta$  between 0.25 and 1.00 by increments of 0.25.

Using the MATLAB (version 7.0) Symbolic Toolbox we reduced the analytic form in (19)-(31) into three equations in  $\mu_t$ ,  $B_t$ , and  $B_{t+1}$  and then using the GAUSS (version 6.0) Nonlinear System solver, we obtained 17,029 equilibrium points of the calibrated model.

Next, for each of the following dependent variables (denoted as  $Y$  below) in the list  $\{\mu_t, s_t, c_{2,t+1}, p_t, p_{t+1}, r_t, B_t, B_{t+1}, B_{t+1} - B_t, B_t - B_{t-1}, r_t B_t / I_{t+1}, p_t M_t, G_t^I / I_t, G_t^C / I_t, G_t^C / G_t^I, G_{t+1}^C / I_{t+1}, G_{t+1}^I / I_{t+1}, G_{t+1}^C / G_{t+1}^I, U_t, V_t\}$  we ran the regression

$$Y = \mathbf{X}\beta + \xi \tag{35}$$

where  $X$  is a vector containing a constant and the eight variables  $\langle \gamma, g, \eta, \theta_1, \theta_2, \delta, \beta^H, \beta^G \rangle$  while  $\beta = \langle \beta_1, \beta_2, \dots, \beta_9 \rangle$  is the associated vector of regression coefficients and  $\xi$  is the disturbance term.

Based on the full sample regression results and the Newey-West HAC standard errors, all of the estimated coefficients are significant at all conventional levels. Since the sample size (17,029) is very large while the controlled variation of the simulation parameters (the independent variables used in the regressions) is kept sufficiently small in order to minimize the computation cost of calibration, the estimated standard errors of the regression coefficients are extremely small. Hence, the corresponding estimated coefficients are always significant. In order to check the robustness of the regression results with respect to sample size, we run Monte Carlo simulations and estimate the regressions in succession with 100, 250, 500 and 1000 observations randomly selected from our 17,029 observations without replacement. The findings indicate that while the sign and magnitude of the estimated coefficients are robust to the sample size (as measured by the mean and median of the estimated coefficients), the estimated standard errors increase as the sample size decreases.<sup>11</sup> Table 1 reports average coefficients obtained from 170 repetitions with sample size 100.<sup>12</sup> In Appendix, we report the percentage of insignificant coefficients at 5% level based on Newey-West HAC standard errors obtained from these repetitions.<sup>13</sup> In the ensuing analysis, we deem a coefficient insignificant if more than 85 of the 170 repetitions result in insignificant coefficients.

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<sup>11</sup>While for sample sizes 500 and 1,000 the results are almost identical to those obtained from the full sample, some of the coefficients become insignificant when sample sizes are 100 and 250.

<sup>12</sup>Full results are available from the authors upon request.

<sup>13</sup>In addition, we conduct standard tests of the assumptions of the classical linear regression model for sample size 100. The evidence indicates that these assumptions are not violated. Nevertheless our results are based on Newey-West HAC standard errors.

Table 1: Regression Results for Sample Size = 100

	constant ( $\hat{\beta}_1$ )	$\gamma$ ( $\hat{\beta}_2$ )	g ( $\hat{\beta}_3$ )	$\eta$ ( $\hat{\beta}_4$ )	$\theta_1$ ( $\hat{\beta}_5$ )	$\theta_2$ ( $\hat{\beta}_6$ )	$\delta$ ( $\hat{\beta}_7$ )	$\beta^H$ ( $\hat{\beta}_8$ )	$\beta^G$ ( $\hat{\beta}_9$ )	$\bar{R}^2$	F - Stat.
$\mu_t$	-0.405	0.343	0.118	0.312	-0.664	0.116	-0.121	0.334	0.168	0.87	83
$s_t$	2.363E-07	2.28E-08	2.61E-08	9.48E-08	-1.984E-07	3.56E-08	-3.71E-08	1.022E-07	5.13E-08	0.93	163
$c_{2,t+1}$	0.458	-0.242	0.458	0.117	-0.242	0.044	-0.046	0.127	0.064	0.98	678
$p_t$	1.207	-0.500	0.015	-0.060	0.116	-0.023	0.023	-0.064	-0.032	0.94	205
$p_{t+1}$	0.948	-0.542	0.321	-0.040	0.080	-0.015	0.015	-0.043	-0.022	0.97	489
$r_t$	1.375	-0.955	0.729	-0.284	0.603	-0.105	0.110	-0.303	-0.152	0.79	49
$B_t$	79.406	-21.652	-4.924	-14.262	30.197	-5.317	5.534	-15.268	-7.653	0.86	78
$B_{t+1}$	158.378	-51.166	-32.471	-33.656	71.220	-12.544	13.041	-36.013	-18.049	0.88	98
$B_{t+1} - B_t$	78.972	-29.514	-27.547	-19.394	41.023	-7.228	7.507	-20.745	-10.396	0.90	117
$B_t - B_{t-1}$	57.430	-21.652	-4.924	-14.262	30.197	-5.317	5.534	-15.268	-7.653	0.86	78
$r_t B_t / I_{t+1}$	1.395	-0.936	0.660	-0.297	0.631	-0.110	0.115	-0.317	-0.159	0.75	41
$p_t M_t$	-3653.595	2083.119	735.036	2366.463	-4982.509	885.663	-922.014	2542.463	1275.142	0.89	109
$G_t^I / I_t$	0.355	0.024	0.141	0.276	-0.592	0.011	-0.011	0.032	0.200	0.98	517
$G_t^C / I_t$	0.599	-0.024	-0.141	-0.276	0.592	-0.011	0.011	-0.032	-0.200	0.98	517
$G_t^C / G_t^I$	1.049	-0.047	-0.311	-0.551	1.254	-0.022	0.021	-0.058	-0.405	0.96	300
$G_{t+1}^C / I_{t+1}$	0.447	0.236	-0.367	0.048	-0.108	0.393	-0.421	0.056	-0.185	0.95	242
$G_{t+1}^I / I_{t+1}$	-0.841	0.700	-0.293	0.249	-0.523	-0.282	0.306	0.261	0.344	0.97	400
$G_{t+1}^C / G_{t+1}^I$	4.549	-0.772	-0.350	-0.369	1.309	2.047	-2.473	-0.459	-1.806	0.84	65
$U_t$	-267.457	-10.843	88.624	110.939	-237.775	-2.685	3.328	-8.174	84.748	0.98	681
$V_t$	-10.304	2.758	0.214	3.322	-1.835	2.261	1.183	1.585	5.618	0.98	585

From Table 1, we first analyze the impact of the monetary policy on the equilibrium outcome. We find that expansionary monetary policy reduces the probability of default in each period since real debt stocks,  $B_t$  and  $B_{t+1}$ , decrease with an increase in the money inflation,  $\gamma$ . The prices of money,  $p_t$  and  $p_{t+1}$ , in terms of real consumption good in period  $t$  and  $t + 1$ , are also negatively related to the money growth rate. The real interest rate,  $r_t$ , and the share of the interest payments in period  $t + 1$  budget,  $r_t B_t / I_{t+1}$ , are decreasing while the fraction of savings that are invested in money,  $\mu_t$ , is increasing in the money inflation. The private consumption of current generation when old,  $c_{2,t+1}$ , is negatively affected by monetary expansion whereas his consumption when young has no significant dependence on  $\gamma$ .

In addition, monetary expansion has no significant effects on the decomposition of government expenditure in period  $t$ . Government investment,  $G_{t+1}^I$ , in period  $t + 1$  is increasing with monetary expansion, while no significant dependence exists for government consumption,  $G_{t+1}^C$ .

Table 1 shows that household utility,  $U_t$ , does not depend on - while government utility,  $V_t$ , is positively related to - the money growth rate,  $\gamma$ . Noting from (8) and (9) that the old living in period  $t$  has the utility

$$(G_t^C + G_{t-1}^I) \ln(c_{2,t}) \quad (36)$$

where

$$c_{2,t} = p_t m_{t-1} + \left(1 - \frac{B_{t-1}}{L_{t-1} w_{1,t-1}}\right) (1 + r_{t-1}) b_{t-1}, \quad (37)$$

we conclude that expansionary monetary policy decreases the utility of the old through real price effects as it decreases the real value of the money they can spend, while not significantly affecting current government consumption in the old's utility function. Hence, monetary expansion immediately punishes the current old.

An additional finding concerns the welfare effects of real economic growth. The current generation's lifetime utility is increasing, while the utility of the current old is decreasing, in the real GDP growth rate,  $g$ .

Our main finding is that the private households are not insensitive towards the weights assigned to public consumption and investment in the government's objective function. Thus, we analyze the impact of the consumption taste parameters  $\theta_1$  and  $\theta_2$ , and investment taste parameters  $\eta$  and  $\delta$  in the government's objective function on the households' utility. We notice that



current generation's lifetime utility,  $U_t$ , is increasing in  $\eta$  and  $\delta$ , the weights of the current and future public investment in the government's utility function. We also note that an increase in the weight of current consumption in the government's utility,  $\theta_1$ , reduces current generation's lifetime utility while the weight of future consumption,  $\theta_2$ , has no significant effects.

On the other hand, as the equations (36), (37), and Table 1 together show, the old in period  $t$  becomes better off with higher levels of  $\theta_1$  and  $\delta$ , the respective weights of the government utilities from  $G_t^C$  and  $G_{t+1}^I$ , and with lower levels of  $\theta_2$  and  $\eta$ , the respective weights of the government utilities from  $G_{t+1}^C$  and  $G_t^I$ .

## 4 Conclusion

In this paper, we construct an overlapping generations model to examine the welfare implications of the different forms of financing and spending by the government.

Our first finding is that seigniorage as a financing instrument alternative to public borrowing through issuing bonds increases the government's utility whereas reduces the old household's utility. However, we obtain, as an unconventional result, that the young household is impartial over the two forms of budget financing of the government.

The negative effect of seigniorage on the welfare of the old in a given period is actually not novel. This very result is interestingly obtained in our model, which deviates from the conventional models that assume (overlapping) generations deriving utility from private consumption allocations, alone. Although the generations in our model enjoy both public consumption and investment goods (in addition to the private consumption good), the equilibrium outcome is unable to compensate for the utility loss of private households stemming from (government's optimal level of) private resources bought by seigniorage from private sector and then converted into public goods.

The main result of the paper is the preference of private households as to the inclination of the government towards public consumption and public investment. The current generation's lifetime utility is strikingly increasing in the weights of the current and future public investment in the government's utility function. We also uncover that an increase in the weight of current consumption in government's utility reduces current generation's

lifetime utility while the weight of the future consumption has no significant effects. On the other hand, the current old becomes better off with the government favoring current consumption or future investment.

The government's attitude in determining her objective as a function of the decomposition of her current spending (in addition to the future decomposition) affects the welfare of the two generations of households, whose lives overlap, dissimilarly. The current generation's lifetime utility is higher under a forward-looking government that favors investment over consumption. On the other hand, the current old does not unambiguously prefer a myopic over a forward-looking government.

This model can be extended in several directions. First, production may be explicitly modeled to show that the different components of government spending may have different effects on the producers and consumers. This may lead to a tradeoff between seigniorage and public borrowing as capital market is introduced to be an additional saving option. Second, government investment may be modeled as a determinant of the growth rate of the economy where it causes a production externality. Finally, an extension of our model can also endogenize the re-election probability of the government.

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## Appendix - Monte Carlo Simulation Results

Table 2: Simulation Results for Regressions with Sample Size 100. The numbers show percentage of insignificant coefficients at 5% level (based on Newey-West HAC standard errors).

	constant ( $\hat{\beta}_1$ )	$\gamma$ ( $\hat{\beta}_2$ )	g ( $\hat{\beta}_3$ )	$\eta$ ( $\hat{\beta}_4$ )	$\theta_1$ ( $\hat{\beta}_5$ )	$\theta_2$ ( $\hat{\beta}_6$ )	$\delta$ ( $\hat{\beta}_7$ )	$\beta^H$ ( $\hat{\beta}_8$ )	$\beta^G$ ( $\hat{\beta}_9$ )
$\mu_t$	0.018	0.000	0.235	0.000	0.000	0.000	0.000	0.000	0.024
$s_t$	0.000	0.565	0.353	0.000	0.000	0.000	0.000	0.000	0.006
$c_{2,t+1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$p_t$	0.000	0.000	0.794	0.000	0.000	0.000	0.000	0.024	0.288
$p_{t+1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.029	0.359
$r_t$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024
$B_t$	0.000	0.000	0.276	0.000	0.000	0.000	0.000	0.000	0.012
$B_{t+1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
$B_{t+1} - B_t$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018
$B_t - B_{t-1}$	0.000	0.000	0.276	0.000	0.000	0.000	0.000	0.000	0.012
$r_t B_t / I_{t+1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029
$p_t M_t$	0.000	0.000	0.300	0.000	0.000	0.000	0.000	0.000	0.006
$G_t^I / I_t$	0.000	0.800	0.000	0.000	0.000	0.312	0.276	0.565	0.000
$G_t^C / I_t$	0.000	0.800	0.000	0.000	0.000	0.312	0.276	0.565	0.000
$G_t^C / G_t^I$	0.000	0.888	0.006	0.000	0.000	0.535	0.529	0.771	0.000
$G_{t+1}^C / I_{t+1}$	0.212	0.329	0.012	0.688	0.624	0.000	0.000	0.841	0.229
$G_{t+1}^I / I_{t+1}$	0.000	0.000	0.018	0.000	0.000	0.000	0.000	0.024	0.000
$G_{t+1}^C / G_{t+1}^I$	0.365	0.847	0.906	0.782	0.588	0.000	0.000	0.882	0.429
$U_t$	0.000	0.765	0.000	0.000	0.000	0.582	0.459	0.735	0.000
$V_t$	0.000	0.000	0.829	0.000	0.000	0.000	0.000	0.000	0.000